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Original Article

The utility and effectiveness of an internal iliac artery balloon occlusion catheter in surgery for large cervical uterine fibroids



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ABSTRACT

Objective: Surgery for uterine cervical fibroids is difficult because of restricted surgical access and risks such as intraoperative bleeding or injury to other organs. The internal iliac artery balloon occlusion catheter (IIABOC) provides effective hemostasis for placenta previa and atonic hemorrhage, and is increasingly used in surgery for uterine fibroids for controlling intraoperative hemorrhage. We investigated the efficacy and safety of the IIABOC for controlling intraoperative bleeding in total abdominal hysterectomies (TAH) and abdominal myomectomies (AM) for large cervical fibroids.

Material and methods: From 2007 to 2014, the IIABOC was used in 22 cases (12 for TAH and 10 for AM) in which cervical fibroids fully occupied the pelvic cavity. Intraoperative blood loss, operating time, sample weight, use of blood transfusion, and injury to other organs were assessed.

Result: Mean blood loss, operative time, and sample weight in the IIABOC cases were 510 mL, 178 min, and 2550 g for TAH; and 727.5 mL, 157.5 min, and 1850 g for AM. Blood loss divided by sample weight in IIABOC cases was significantly lower than that in non-IIABOC cases during the same time period, for both TAH and AM. Allogeneic blood transfusion was not necessary, and complications of injury to other organs did not occur in any of the 22 cases.

Conclusions: For large cervical fibroids with limited operating space, surgery was performed under bleeding control by occlusion of the internal iliac artery with an IIABOC. This technique enables control of hemorrhage and safe operative management in gynecological surgery.

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Introduction

Gynecological surgery requires familiarity with complex pelvic anatomy and careful attention to the control of hemorrhage. The internal iliac artery balloon occlusion catheter (IIABOC) is used for intraoperative control of hemorrhage by placement in the internal iliac artery between the superior gluteal and uterine arteries to block blood flow to the uterus. The IIABOC has been reported to be an effective method for control of hemorrhage in cesarean section

for placenta previa and for hemostasis in postpartum hemorrhage [1–4]. Cervical fibroids can occupy space in the pelvic cavity, shift the position of the ureter, and engorge the uterine artery and vein, resulting in a high degree of difficulty in performing the surgery. In cases of large cervical fibroids, hysterectomy may be unavoidable even if fertility preservation is desired, because of massive bleeding associated with myomectomy. Surgery for cervical fibroids is problematic because of the restricted space in the pelvic cavity. This means it is impossible to perform typical procedures such as uterine artery separation and cut-off, or the Rubin method for the control of hemorrhage in abdominal myomectomy (AM) [5], and it is difficult to manage the parametrium and uterine artery during total abdominal hysterectomy (TAH) because of the risk of damage to ureter or bladder and massive hemorrhage. We have controlled intraoperative hemorrhage by using the IIABOC in gynecological surgery, including difficult surgery for large cervical fibroids. In this

Abbreviations: AM, abdominal myomectomy; IIABOC, internal iliac artery occlusion catheter; MRI, magnetic resonance imaging; TAH, total abdominal hysterectomy.

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study, we examined the efficacy and safety of the IIABOC for the control of intraoperative hemorrhage in TAH and AM for large cervical fibroids.

Material and methods

From 2007 to 2015, we performed 12 TAHs and 10 AMs required the IIABOC because the pelvic cavity was filled with large cervical fibroids. Gynecological pelvic examination, transvaginal ultrasound, pelvic magnetic resonance imaging (MRI), and cervical cytology (Pap smear) were performed to exclude gynecological malignancy, and benign uterine fibroids were diagnosed. Pelvic MRI was used to evaluate the number, size, and position of fibroids to determine whether there was adequate surgical space in the pelvic cavity despite displacement by fibroids, and whether the cervix was elongated by fibroids. The criteria for application of cases using the IIABOC is large cervical fibroids fully occupying the pelvic cavity confirmed by MRI, no mobility of the uterus, non-confirmation of cervix at the pelvic and speculum examination, and no effective reduction of fibroids volume after 6 times injections of 1.88 mg Gonadotropin-releasing hormone agonists (GnRHa). Intraoperative blood loss, operating time, sample weight, use of blood transfusion, and injury to other organs were assessed and evaluated in comparison with 506 cases of TAH and 295 cases of AM performed without using the IIABOC during the same period. Control group were large or non-large, multiple or non-multiple, and cervical or non-cervical fibroids cases which were not high degree of difficulty surgeries requiring the IIABOC.

All surgeries were performed by same skilled surgeons. Statistical analysis was performed independent t-test. Statistical significance was set at p value < 0.05 . This study is a retrospective-case control study, with the approval of the ethics committee in our hospital, we explained to the patient about the use of IIABOC and got with consent.

IIABOC

The IIABOC was used with the assistance of an interventional radiologist. On the day prior to surgery, catheterization was performed via the contralateral inguinal femoral artery by the Seldinger technique, with the catheter advanced through the common iliac and the internal iliac artery, past the superior gluteal artery, and placed proximal to the uterine artery. Pelvic angiography confirmed the location of the dominant vessels and blood flow from the uterine artery. The balloon remained in the internal iliac artery between the superior gluteal and uterine arteries ensuring prevention of blood flow to the uterine artery. This procedure was performed on both sides. The catheter was extended to the out of surgical field for inflation and deflation of the balloon in the appropriate timing during surgery by assistant. Blood flow from the external iliac artery to the femoral artery was monitored during surgery with a pulse oximeter on both lower extremities. After the surgery the catheter was removed immediately and the catheter insertion site should be pressured for 24 h.

TAH

Laparotomy for TAH requires attention to the possibility of bladder injury due to the proximity of large fibroids. After resection of the round ligament and proper ligament/suspensory ligament, the bladder was separated from the uterus. If the sacrouterine ligament was determined or visible, both sacrouterine ligaments were resected, and both ureter should be detected on the common iliac artery and into the pelvic cavity. The balloon was inflated to occlude the uterine artery before the parametrium could be treated.

The bladder was further separated from the uterus, which was gradually brought outside of the pelvis. The parametrium and the uterine artery were treated under determining the ureter through the side of the uterus. Finally, after cutting off the vaginal tract, the uterus was removed. The balloon was deflated after closing the vaginal tract and it should be confirmed that there was no bleeding from the wounds after restoration of blood flow to the pelvis.

AM

Laparotomy for AM requires attention to the possibility of bladder injury as in laparotomy for TAH. As the fibroids were cervical, the position of the cervix had to be confirmed, and an incision was performed with care to avoid damage to the cervix. After injection of vasopressin, the uterine artery was occluded by expanding the balloon. No bleeding from the removal site of fibroids should be confirmed after resection of all of the fibroids and deflation of the balloon leading restoration of blood flow to the pelvis and the uterus.

Results

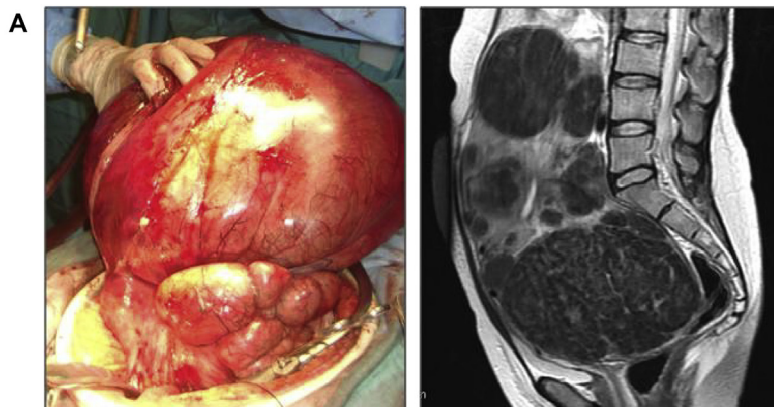
The IIABOC was used in 22 cases that had been diagnosed by preoperative pelvic MRI as having cervical fibroids and inadequate surgical space in the pelvic cavity (Fig. 1A–C). There were 12 TAH cases and 10 AM cases (Table 1). Placement of the IIABOC is shown in Fig. 2. Angiography confirmed cut-off blood flow to the uterine artery by inflation of the IIABOC. The means and ranges for blood loss, operating time, and sample weight in TAH and AM cases with and without the IIABOC are shown in Table 1. The index of blood loss divided by sample weight was significantly lower in IIABOC cases compared with non-IIABOC cases for both TAH and AM (Fig. 3). The mean hemostasis time was the same for TAH and AM (Table 2). In all, 22 cases requiring the IIABOC, there were no allogeneic blood transfusions or complications such as injury to the bladder, ureter, or rectum (Table 3). No additional any complications were observed furthermore after surgery.

Discussion

The IIABOC has been reported to be effective for hemorrhage control in cesarean section for placenta previa and for hemostasis in postpartum hemorrhage [1–4]. As the uterine artery delivers 90% of the blood flow to the uterus [6], the control of this blood flow is effective for preventing uterine bleeding. There are also reports that the IIABOC can effectively control bleeding in cesarean hysterectomy [7], laparoscopic myomectomy [8], and laparoscopic hysterectomy [9]. Surgery for uterine fibroids is a common procedure performed by gynecologists [10,11].

The location and size of the fibroids are important factors determining the difficulty of the surgery [12]; the problem in surgery for cervical fibroids is very restricted operable space in the pelvis. It makes increasing risk of injury to other organ such as ureter, rectum or the uterine artery and vein in TAH, difficulty of control bleeding in AM, and injury to the bladder at the time of laparotomy in both surgeries. Despite this problem, we safely performed surgery for large cervical fibroids in cases of TAH and AM with effective control of intraoperative hemorrhage by using the IIABOC to control bleeding from the uterus via the uterine artery.

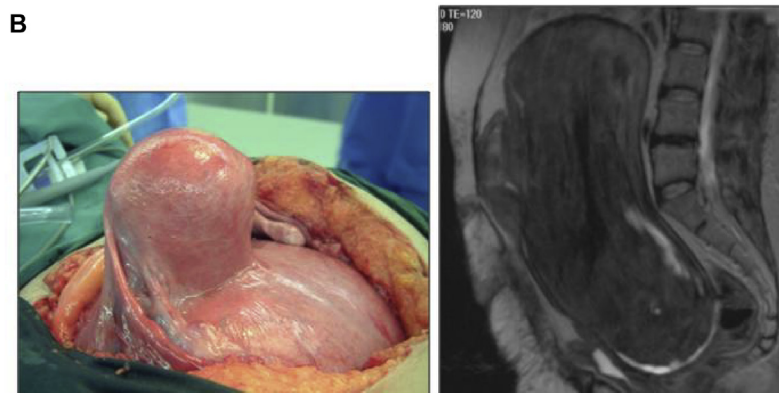
There was no significant difference in the volume of blood loss between with and without IIABOC in TAH. In AM requiring the IIABOC, the volume of blood loss was slightly higher than in AM without the IIABOC. This does not alter the fact that the IIABOC in AM can suppress active hemorrhage during the operation. Because the volume of fibroids determined the use of the IIABOC, and the



A. huge uterine cervical fibroid

B. MRIT2 weighted image sagittal

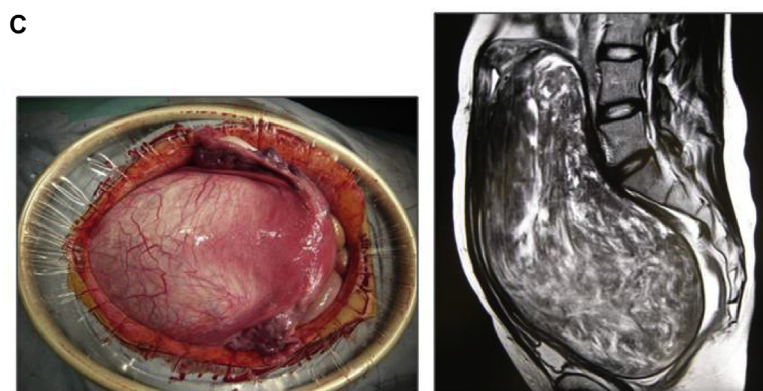
- 55 years old, bloodloss: 1206 mL, operative time: 146 minutes, sample weight: 7100 g
- A; large and huge cervical fibroid entirely occupied pelvic cavity.
- B; MRI showed cervical multiple fibroids exceed the pelvic cavity.



A. huge uterine cervical fibroid

B. MRIT2 weighted image sagittal

- 52 years old, bloodloss: 700 mL, operative time: 200 minutes, sample weight: 7400 g
- A; large cervical fibroid entirely occupied pelvic cavity.
- B; MRI showed large cervical fibroids exceed the pelvic cavity.



A. large uterine cervical fibroid enlarging cervix

B. MRIT2 weighted image sagittal

- 28 years old, bloodloss: 1310 mL, operative time: 216 minutes, sample weight: 2460 g
- After resection of fibroid, the cervical arthroplasty was performed.
- A; There is not operative space in pelvis due to cervical fibroid.
- B; MRI showed enlarged uterine cervix due to large cervical fibroid.

Fig. 1. TAH case.

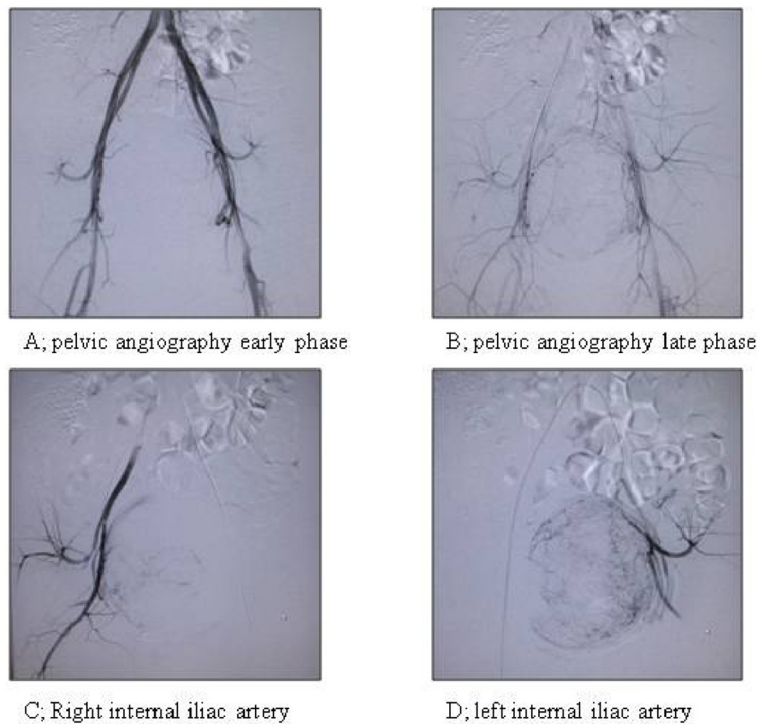
Table 1

Summary of total cases in TAH and AM.

TAH	IIABOC (n = 12)	Non-IIABOC (n = 506)	p Value
Age (years)	49.5 (36–62)	47.0 (34–69)	0.519
Blood loss (mL)	510.0 (65–1928)	350.0 (2–4561)	0.379
Operative time (minutes)	178.0 (116–300)	165.5 (57–686)	0.964
Sample weight (gram)	2550.0 (1330–7400)	1063.5 (50–14500)	0.005
Blood loss / sample weight	0.246	0.438	0.033
AM	IIABOC (n = 10)	Non-IIABOC (n = 295)	p Value
Age (years)	35.5 (28–40)	38.0 (23–63)	0.019
Blood loss (mL)	727.5 (80–1962)	390.0 (10–1962)	0.085
Operative time (minutes)	157.5 (126–218)	160.0 (52–366)	0.637
Sample weight (gram)	1850.0 (1200–10500)	694.0 (7–12000)	0.048
Blood loss / sample weight	0.425	1.528	0.040

Values are expressed as means (range).

- In TAH, there was a significant difference in sample weight between IIABOC cases and non-IIABOC cases.
- In AM, there were significant difference in age and sample weight between IIABOC cases and non-IIABOC cases.



Pelvic angiography was performed for confirmation of placement IIABOC prior to surgery. The balloon was placed in internal iliac artery to block the blood flow to the uterine artery.

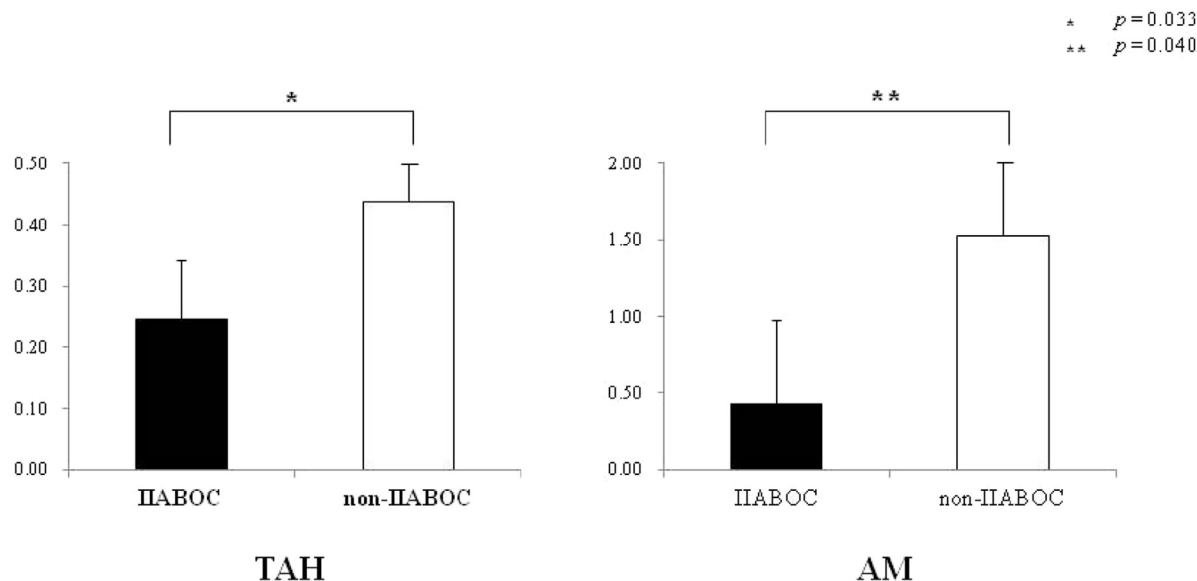
Fig. 2. Placement of IIABOC and pelvic angiography.

bleeding was prominent in the neovascular tissue surrounding the fibroids, cases requiring the IIABOC may have had a relatively greater risk of intraoperative hemorrhage. There was no significant difference in operation time between surgeries performed with and without the IIABOC in both of TAH and AM, excluding the time taken to place and retrieve the IIABOC.

Bleeding during surgery was controlled by the IIABOC in both type of operation, and there was no obstacle to performing surgery using the IIABOC; therefore it was possible to perform a safe and smooth operation. The occlusion of the internal iliac artery by the IIABOC results in cessation of blood flow to the superior vesical artery and ureteral branches of the uterine artery. This enables the control of hemorrhage during release of the bladder and ureter, thus preventing injury to these organs.

The median sample weights for IIABOC TAH and AM cases were significantly greater than the those for non-IIABOC TAH and AM cases.

One of the important things of surgery for large cervical uterine fibroids is to avoid the risk of amount bleeding, likewise the smooth progress of the surgery. In the group using IIABOC, the amount of bleeding was larger than the group not using IIABOC but there was no significant difference, the sample weight was heavier and there was a significant difference. The index of blood loss divided by sample weight was significantly lower in IIABOC cases compared with non-IIABOC cases in both TAH and AM. Some of the cases in which the IIABOC was not used had higher blood loss because the bleeding was not effectively controlled. The preoperative diagnosis of large cervical fibroids by MRI was important for reduction of the



• There was a significant difference in the index of blood loss divided by sample weight between IABOC cases and non-IABOC cases in both TAH (0.246 and 0.438) and AM (0.425 and 1.528).

Fig. 3. Index of blood loss/sample weight in TAX and AM.

Table 2
IIABOC hemostasis time in TAH and AM.

	TAH	AM
Hemostasis time (minutes)	60 (29–105)	60 (35–65)

Values are expressed as means (range).

- The time of using the IIABOC was limited to about one hour in both surgeries.
- Blood flow from the external iliac artery to the femoral artery was monitored during surgery with a pulse oximeter on both lower extremity.
- Lower extremity peripheral neuropathy, pudendal nerve paralysis, and complications from blood flow such as tissue necrosis were not observed in both AM or TAH cases.

Table 3
Summary of complications.

	IIABOC (n = 22)	non-IIABOC (n = 801)
Blood transfusion	0 (0)	13 (1.62)
Injury to ureter or bladder	0 (0)	4 (0.50)
Injury to intestinal tract	0 (0)	1 (0.12)
Infection	0 (0)	6 (0.75)
DVT/PTE	0 (0)	0 (0)
Reoperation	0 (0)	2 (0.25)

Values are expressed as number (percentage).

DVT: deep vein thrombosis

PTE: pulmonary thromboembolism.

- There were neither allogeneic blood transfusions nor complications such as injury to other organs in IIABOC cases.

perioperative burden. According to this index, the bleeding volume could be reduced according to the sample weight by using IIABOC in the surgery of large cervical uterine fibroids. We suggest that the IIABOC can control intraoperative bleeding by reducing the amount of blood lost in relation to the mass of fibroid removed.

Notably, the IIABOC enabled myomectomy for large cervical fibroids, allowing preservation of the uterus and preservation and recovery of fertility [13].

Injection of vasopressin [14,15] and the Rubin method [5], which involves the compression of the uterine arteries, are generally used during myomectomy [16,17] because of the expectation of severe

hemorrhage. Although permanent embolization of the uterine artery is also used for the control of hemorrhage in myomectomy [18], it is reported that oxidative stress caused by blood flow interruption causes organ dysfunction [19], and there is a possibility that uterine artery embolization will cause dysfunction of the uterus and ovaries [20]. Temporary blocking of uterine blood flow using the IIABOC may be effective in fertility preservation, although there is no published study of uterine and ovarian dysfunction associated with blockage of the uterine artery. In orthopedic surgery, tourniquet ischemic time averages 145 ± 25 min (range, 120–308 min), with peripheral neuropathy occurring in about 7% of cases [21]. In surgery for abdominal aneurysms, the redox status of glutathione, an antioxidant, changes with interruption of arterial blood flow for one or more hours [22]. Therefore, we limited the intraoperative use of the IIABOC to about 1 h.

Furthermore, lower extremity peripheral neuropathy, pudendal nerve paralysis, and complications from ischemia such as tissue necrosis were not observed in AM or TAH cases by monitored with a pulse oximeter. Although the blood flow to the uterus was interrupted for about 60 min during surgery and the deficit in the uterus after removing large cervical fibroids in AM cases using the IIABOC, the menstruation was resumed in a few months after the surgery. GnRHa is often used for the reduction of uterine fibroids volume before surgery [23]. GnRHa which were used in all cases and leading to success in reduction of the fibroids volume in non-IIABOC cases, did not effective reduce fibroid volume but did suppress menstruation in cases requiring the IIABOC. One of the reason for using the IIABOC was non-effective reduction of fibroids volume after injection of GnRHa, although uterine fibroids are hormonal dependent tumor. The suppression of menstruation was enabled preoperative donation of autologous blood and reduced the need for allogeneic blood transfusion. Autologous blood collection during surgery is also useful in this respect.

In gynecological surgery, it is important to understand pelvic anatomy, including the dominant vasculature in the pelvis, in order to control intraoperative hemorrhage. Even in cases with inadequate pelvic operative space because of huge uterine cervical

fibroids, it is possible to perform surgery safely by controlling hemorrhage using the IIABOC. This technique effectively controls hemorrhage in obstetrics and gynecological surgery, and should become an important tool in surgery for large uterine cervical fibroids.

Key message

The internal iliac artery balloon occlusion catheter is not only of use in obstetric but also in challenging cases of gynecological surgery for uterine cervical fibroids including fertility enhancing procedures.

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Conflict of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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